

The Energy Challenge

California's energy system today faces a challenging future. Our use and choice of energy sources will dramatically affect our environment, our economy, and the legacy we pass on to future generations. By exploring all our available energy resource and efficiency opportunities, we will reap societal benefits. Informed decisions can slow the accumulation of atmospheric CO₂ which may cause or aggravate global warming, reduce congestion and air pollution, increase resource diversity, and improve security from fuel supply disruptions. The more efficiently we use our existing energy, the less we will have to depend on potentially unstable foreign sources.

The greatest energy challenge facing California is our nearly 100% dependence on petroleum for transportation. Transportation accounts for nearly half of all energy consumed in the state according to the 1992-93 *California Energy Plan*. California has become the third largest gasoline consumer in the world behind the United States as a whole and the former Soviet Union. Accordingly, the introduction of alternative transportation fuels and vehicles is an essential element of our state's energy and air quality policies. The goal for 2003 is 10% zero emission vehicles.

California's transition to a diverse and clean energy supply system is already in progress. The key component of that portfolio is energy efficiency. Per capita consumption has declined by 15% since 1978 due largely to improved energy standards for new buildings and appliances and utility-sponsored conservation programs. That "conserved" energy is equal to eight 1,000-megawatt power plants! But there is still room for improvement. Both Japan and Germany consume half as much energy to produce the same amount of goods and services as the United States.

During the 1980s, California responded swiftly to reduce oil dependency in the generation of electricity. In 1980, over 50% of our electricity came from oil. Today, that figure is less than 6%. California now has 50% of the world's geothermal plants, 82% of the installed wind

capacity, and 99% of the utility-sized solar plants. Twelve percent of our electricity comes from those renewable energy resources—solar, wind, biomass and geothermal.

A complete transition, particularly in transportation, our predominant area of energy consumption, will require millions of individual decisions about the purchase of automobiles, refrigerators, homes, and other energy-consuming products. Teachers are charged with helping students understand the energy choices of today while preparing them to become active participants in making those choices tomorrow. Today's students must be more than decision makers. They will be responsible for keeping California on the leading edge of new energy technology, a vital part of increased efficiency and diversity. The intelligence and ingenuity of today's students is perhaps our most valuable renewable energy resource.

READ MORE ABOUT IT by ordering the most recent edition of the *California Energy Plan* from the California Energy Commission Publications Office, 1516 Ninth Street, Sacramento, CA 95814. This free publication, complete with color photos, charts, and graphs, will enable you to include the most current energy facts in your lessons.

Energy as a Key Theme in Environmental Education and Science

Exploring energy issues provides a natural introduction to understanding and solving environmental problems. Why? Because energy is the common currency between two economies-nature's and our own. Tracking the flow of energy through both natural and human communities reveals the far reaching consequences of everyday choices.

Link Between Disciplines

Energy is an abstract, but fundamental concept in science. It is the GO and GROW of things, the essential force behind change. Everything that happens in the universe, from the eruption of volcanoes to the sprouting of a seed to the moving of people, involves the transformation of one form of energy to another. Thus, it is not surprising that energy is one of the six "themes" around which both the *Environmental Education Compendia* and *Science Framework for California Public Schools* (1990) are organized. The Framework notes that "Energy can be taught as a bond linking various scientific disciplines."

Traditional Exploration in Physical Science

Earth's primary source of energy is the sun. It is within the physical sciences that students traditionally explore the various manifestations of energy (heat, motion, light, sound, electricity, and so on), its states (mechanical--kinetic & potential, chemical, electrical, magnetic, nuclear, and radiant) and its characteristics.

Geologic Process is Fundamental

Through the earth sciences, students expand their knowledge of energy by understanding that the forces on the earth's surface such as wind and rain are responsible for many geological processes. Those cycles and processes are then responsible for the energy that fuels our society--both the renewable sources such as water and wind, and the nonrenewable sources such as petroleum and coal. Students begin to appreciate these distinctions, the limitations of each, and the changes that occur as we use

energy. These insights help them understand the implications of their choices about which energy source to use.

The Grow of Things

All living systems require energy to grow and reproduce. Energy pervades the biological sciences because it underlies all biochemical reactions. Using the energy from sunlight, plants are able to make food out of air and water.

Quality of Life

From a social science and historical perspective, our energy future will probably be different than our energy past and present. The development, distribution, conversion and use of energy has economic, environmental, social, and political impacts which affect that future. Energy is also an important element in the considerations of ethical behavior and the relationship of science and technology to society. Students begin to appreciate that there are wise and efficient management practices which can extend the useful life of the earth's energy resources. Their individual choices do make a difference.

About This Compendium

We recognize that the teacher who understands the importance of energy is faced with a daunting challenge—how to incorporate it into an already crowded curriculum, how to treat energy issues fairly and comprehensively, and how to easily find quality lesson plans and support materials. This *Compendium for Energy Resources* has been developed to address these problems.

Review Team

Teaching materials were evaluated in early 1991 by a team of thirty-four environmental educators listed on page ii from Northern and Southern California, Arizona and Nevada. These educators were chosen based on their knowledge and experience in environmental and energy education. They also represent the full range of teaching experience from kindergarten through twelfth grade.

Materials

Staff at Sonoma State University Energy Center conducted a nationwide search in 1990 and 1991 for energy curriculum. They obtained materials for all grade level spans, although most writers targeted materials for the upper middle grades 4-6. Few writers attempted to develop materials for K-12 or middle school.

After an initial screening, forty-five materials were selected for evaluation in the summer of 1991. Other energy materials worth consideration that were not available in 1991 are listed on page 39. Although not reviewed for the compendium, they either won national awards for energy education or rated well in subsequent compendia, e.g. *Integrated Waste or Human Communities*. Readers are invited to apply the evaluation criteria on pages 36-37 to these materials or others to determine their attention to the full range of energy issues and alignment with the *California Frameworks*.

The twenty-eight materials that received an overall grade of B- or better have full entries in this compendium. The other materials are listed on page 38.

For ease of use, the table of contents is divided into four grade-span sections. At the K-3 level, thirteen materials are recommended. Nineteen materials are recommended for the upper elementary level, grades 4-6, including two in Spanish. In contrast, at the middle school level, grades 7-9, only nine materials are recommended, and at the senior high level grades 9-12, eleven materials are recommended.

Compendium Listings

In order to conserve resources, the materials are listed only once, in the order of their performance on the evaluation. The first four materials are excellent teaching aids and we have included an entire activity with each one. The next eighteen materials have a single sample page included with the evaluation information. The last six entries, with average scores below 2.7, include no sample pages and have limited information from the evaluation.

The bulk of the *Compendium* provides both descriptive and evaluative information about each piece of teaching material. The information gained from the evaluation was summarized in the curriculum rating guide or “report card” that addresses teaching and learning qualities, presentation and organization, general content, and specific energy content. Comments from the evaluating teachers are also included along with basic ordering information. (See Key to the Evaluation, page 5.)

Funding

This project was funded through a cooperative agreement between the Governor’s Office of Planning and Research/California Energy Extension Service, the California Department of Education’s Environmental Education Grant Program, and Sonoma State University. The U.S. Department of Energy and the Energy Offices in Arizona and Nevada also collaborated in the actual review of materials.

Significant Findings

While the *Compendium* was designed to identify the strengths and weaknesses in existing energy education materials, it was also intended to identify gaps and provide direction for new curriculum development in energy. None of the materials received an average score above 3.4 out of 4 possible points. When taken together, the findings from the review of energy, water, and integrated waste materials are similar.

Development and Presentation

Half of the top ten materials were developed under the auspices of state energy offices or departments of education with the remainder fairly evenly split between non-profit organizations and private energy curriculum developers. Overall, half of the materials were developed by state government, just over one third by non-profits and just over one quarter by private firms. Few materials indicated field testing prior to publishing. Although many credited original sources, similar lessons related to meter reading, insulation testing, energy audits, etc. appeared in many materials. Few displayed original research or ideas.

Grade Level Coverage

The greatest percentage of high scoring energy materials were for grades 4-6 as was the case in both the *Compendia for Integrated Waste Management and Human Communities*. The lowest quality materials

were at the senior high level, a finding similar to the *Compendium for Human Communities*.

Pedagogy

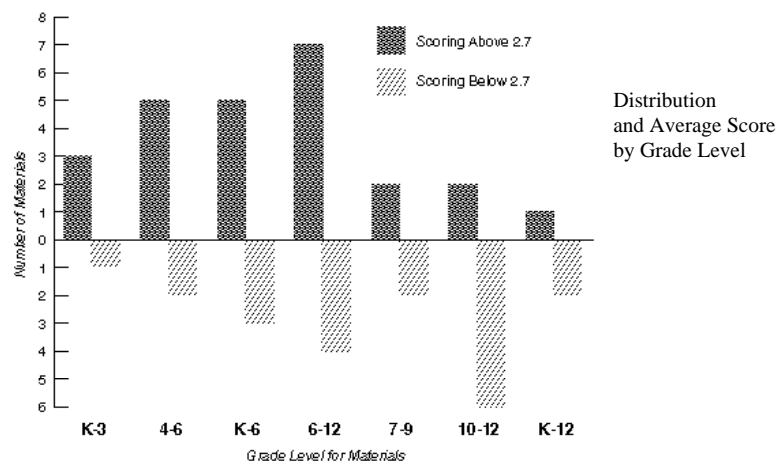
Although the *Compendium* identified many excellent materials, even these materials would benefit from refinement, particularly in light of the direction California is moving with the educational standards presented in the *Frameworks*. Most materials were lacking in authentic assessment. Few reflect advances in cognitive science such as the application of constructivist learning theory where students construct knowledge. Many used experiments that were described as too “cook-book” in methodology.

Multilingual Materials

Very few materials were available in languages other than English. Two materials were available in Spanish at the upper elementary level. The good news is that one is of particularly high quality. Some provide cross-cultural perspectives on habitat design, living standards, and behaviors. Clearly, more materials need to reflect cultural diversity, be provided in the primary languages of families in California, and developed at all student levels.

Energy Content

It is noteworthy that the average score for energy content alone was a C+, only 2.5, much lower than other items rated. Materials that include statistical data, e.g. energy usage trends, renewable energy consumption, etc. are easily outdated. More importantly, few materials differentiated between energy supply options for the United States as a whole and California. California is different in several areas, notably the role renewable energy or coal and the impact of transportation petroleum use. However, teachers can easily include updating of this information as an educational activity by using the California Energy Plan which is available free from the California Energy Commission.



Key To The Evaluation

Title

Address and
Phone
of Publisher



On the right side of the page or on the facing page,
you will find a sample activity from the
material being evaluated.

Here you will find a short annotation. Number of pages, price, and year of publication are noted at the end of this paragraph (in parentheses).

REPORT CARD	
grades K-12	
Teaching and LearningA-	Disciplines:
Presentation and OrganizationA-	Interdisciplinary
	Math
	Science
	Social Science
	Geography
Energy ContentB	Language Arts

Each piece of teaching material was
given a "sun" rating based on an overall
average score. The materials that
received the best evaluations have a four
sun rating. The next best materials got a
three and one half sun rating, and so on.

Teaching and Learning: The pedagogy and general content is
evaluated here.

Presentation and Organization: The ease of use is evaluated here.

Energy Content: Content accuracy and breadth is covered here.

Teachers' Thoughts: Illustrative comments made by evaluating
teachers are highlighted in this section.

This "Report Card" tells you how the
particular piece of teaching material was
rated. There is a copy of the evaluation
tool used on pages 36-37. This tool was
used to determine the letter grades. Grade
level and the discipline(s) addressed are
also included.

Energy Education Teaching Materials

Science Alive! Unit 1: Energy Flow

Science-Oriented Learning
Ocean Studies: MARE
c/o Craig Strang
1324 Derby Street
Berkeley, CA 94702
(510) 642-5008 or
(510) 644-2054



This is one part of an entire set of environmental education materials. These activities are set up to be used as units or individually. All activity worksheets are in both English and Spanish. While all the basics are covered, the more technical aspects of energy are not. (175 pages; \$25/unit, \$115 for a set of 5; 1988)

REPORT CARD

grades 4-6

Teaching and LearningA-	Disciplines:
	Art
Presentation and OrganizationB+	Language Arts
	Math
	Science
	Social Studies
Energy ContentB+	

Teaching and Learning: Strong connections are made between energy and real-life situations. The activities do not skirt energy values and their societal implications.

Presentation and Organization: There are clear objectives. High quality student materials are provided. Organization is straight forward and simple to use.

Energy Content: There is a sound base of energy information.

Teachers' Thoughts: Accolades from all for this bilingual and culturally sensative curriculum material. The print was a little hard to read, but the fact that it makes hands-on activities available in both Spanish and English seemed to outweigh this deficit. You'll find "different activities than in many other curricula, e.g. linking energy to archeology. The connections to society were very clear. All and all it was hailed as "An excellent and practical program!"

Conserve and Renew: Energy Education Activities for Grades 4-6

Earth Lab
Sonoma State University
1801 Cotati Avenue
Rohnert Park, CA 94928
(707) 664-2577



This collection of 23 activities is organized into sequential units, but each activity can be used individually. A glossary and a resources section are included. Each activity includes objectives, background section, materials list, step-by-step instructions, discussion questions, and extensions. (157 pages; \$12; 1990.)

REPORT CARD

grades 4-6

Teaching and LearningB+

Presentation and
OrganizationA-

Energy ContentB+

Disciplines:

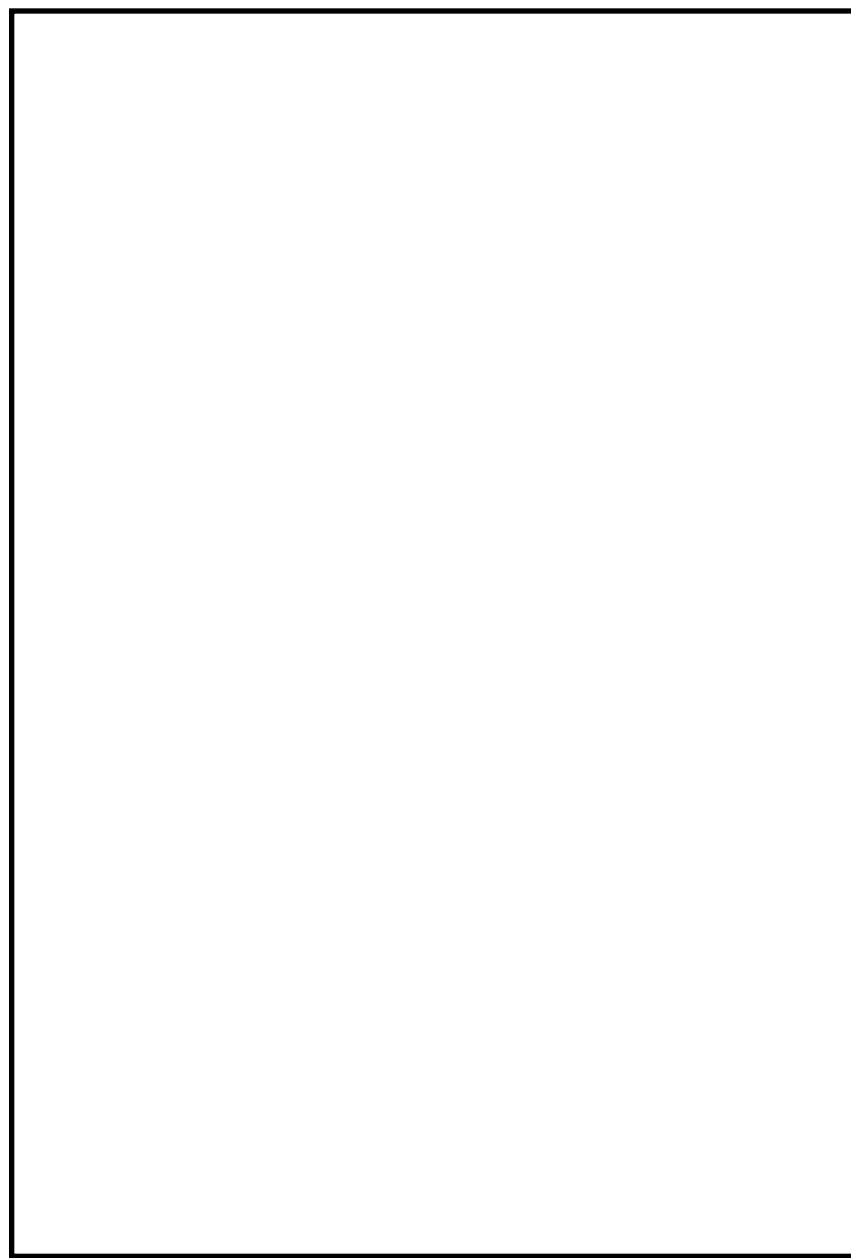
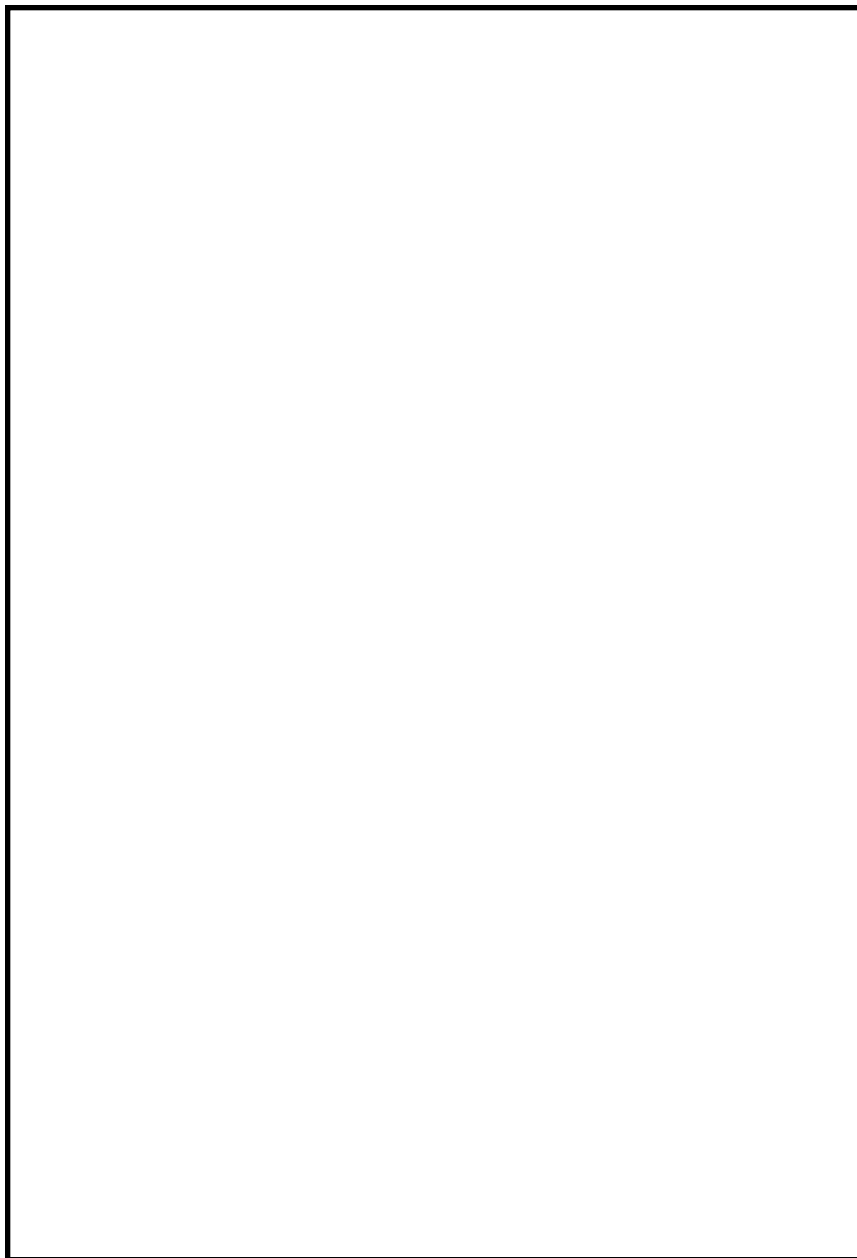
Art
Interdisciplinary
Language Arts
Math
Science
Social Science
Science, Tech. & Society

Teaching and Learning: The activities are all hands-on, include critical thinking, and are adapted for large and small groups. A strong connection is made between the energy information and real experience. There is a good balance between the amount of information covered and depth of treatment.

Presentation and Organization: Goals and objectives are clear and student materials amply provided. The text is engaging and the illustrations are fun. In a few instances, teachers may want more background information than is provided.

Energy Content: While energy dynamics, conservation and renewable energy activities are discussed in-depth, brief activities for other energy sources are included.

Teachers' Thoughts: These materials hit a happy medium. The focus is narrow (conservation and renewable energy), but a lot of general energy content is offered. The format is teacher-friendly, and the bibliography is a wonderful resource. Teachers felt these materials were comprehensive and fit into their curricula.



Energy 90

Enterprise for Education, Inc.
1316 Third St., #103
Santa Monica, CA 90401
(310) 394-9864



These extensive materials have activity guides for teachers, an attractive student booklet, and are designed to either enhance traditional courses with energy information or to create an interdisciplinary course in energy. An 8-part (8-book) set of books go with the Teacher's Guide, and any part can be used separately. Designed for 8th graders, these may be useful in grades 5-12. (1250 pages: \$49.50 for the 8-volume Teacher's Guide and \$2.15 each for the student booklet; 1991.)

REPORT CARD

grade 5-12

Teaching and LearningB+

Disciplines:

Presentation and
OrganizationB+

Science
Social Studies

Energy ContentB+

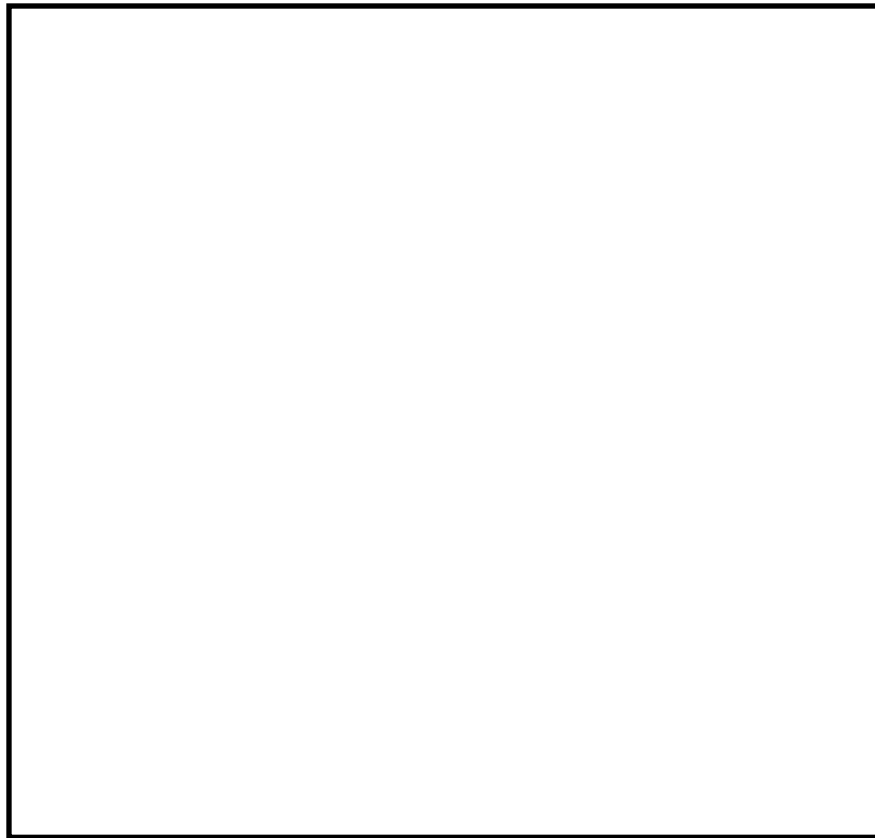
Teaching and Learning: These materials use the scientific process in hands-on activities. There is usually a connection to student's experience. Concepts are covered in-depth.

Presentation and Organization: The goals and objectives are clearly stated in the beginning, but the organization becomes cumbersome from there on.

Energy Content: At times the connection of energy to values and society is vague, but otherwise energy is covered very thoroughly.

Teachers' Thoughts: This is a HUGE collection of material, enough to be intimidating to some of the teachers reviewing it. The student materials are bright and interesting. Most of the teachers said, with some effort and time, this is a wonderful resource. "There is everything you'd ever need to teach about energy in here somewhere. All you have to do is find it!"

Note: Energy Skill Builders on page 27 are abbreviated versions of some of these materials.



California State Environmental Education Guide

Alameda County Office of Education
Media Sales
313 West Winton Avenue
Hayward, CA 94544-1198
(510) 670-4168



This is a guide for teaching environmental education which contains a seven- activity unit on energy. Only the energy unit was evaluated.
(323 pages, \$17.95 + tax; 1988.)

REPORT CARD

grades K-6

Teaching and LearningB+

Disciplines:

Presentation and
OrganizationB+

Language Arts
Math
Science
Social Studies

Energy ContentB-

Teaching and Learning: This guide does a particularly good job of getting students out of the classroom and handling information in depth.

Presentation and Organization: It is very easy to find the objectives and goals for each activity and the entire book is thoughtfully organized. More illustrations would have been welcome.

Energy Content: There is some energy conservation included here but the coverage of renewable energy was not thorough. It should be noted that this is not an energy education publication, rather it includes one unit on energy.

Teachers' Thoughts: Everyone noted the superior organization and ease of use. The energy content is understandably limited but content covered is in good depth. Everyone appreciated the fact that each activity is referenced to the state frameworks.

